SELECTIONS FROM THE RECORDS OF THE BOMBAY GOVERNMENT.

IRRIGATION SERIES.—No. V.

A

PAPER

ON

IRRIGATION IN THE DECCAN AND SOUTHERN MARATHA COUNTRY.

BY

COLONEL PLAYFAIR, R.E.,
SUPERINTENDING ENGINEER FOR IRRIGATION.

WITH ONE MAP AND FOUR SKETCHES.

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IRRIGATION

IN THE

DECCAN AND SOUTHERN MARATHA COUNTRY.

No. 336 OF 1866.

PUBLIC WORKS DEPARTMENT,
Superintending Engineer for Irrigation's Office,
Poona, 20th April 1866.

To THE REVENUE COMMISSIONER, Southern Division.

SIR,—I have the honour to forward for your perusal, and subsequent submission to Government, a Report on the Irrigation of the Deccan and Southern Maratha Country. You will observe, that the principal part of my report on the Gokak Irrigation Project, which you have already received separately, has been inserted for the sake of completeness.

2. As in answering a reference from Government with regard to the Mulpurba River, in which His Excellency Sir Bartle Frere takes a great interest, I referred to this Report, and said it would be soon submitted, I shall feel obliged by your sending it on as early as you conveniently can.

I have the honour to be, &c.,
J. W. PLAYFAIR, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

No. 1385 OF 1866.

PUBLIC WORKS DEPARTMENT,
Camp Mahabuleshwur, 23rd April 1866.

Submitted to Government.

J. W. HADOW,
Acting Revenue Commissioner S.D.

PREFACE.

On receiving charge of the Deccan Irrigational Department, I found that my predecessor Colonel Fife (under whose auspices this special department was organized, and who from his long connection with the Canal Department in Sind had acquired a greater experience than any other officer in our corps,) had, after some years' attention to the system required for the Deccan, left on record his opinion, that high level canals would alone solve the problem. He proves that a small tank system on tributary streams must fail: in the first place, because the cost of storing the water is too great in comparison with the return to be expected; and secondly, that as the supply of such tributary streams is likely to fail in seasons of drought, the tanks would be dry at the very time they would be most wanted. He insists upon the necessity of turning our attention to the large rivers fed by the never-failing rain-fall of the Western Ghats, and advocates storage lakes on them with derived high level canals. Colonel A. Cotton I believe takes the same view. I extract here a paragraph of an unfinished report which Colonel Fife lately sent me; he had commenced it with regard to the high level canal he proposed to lead from the Poona water supply tank on the Moola River, when the dam had been raised to its final height of about 125 feet.

Extract paragraph 6.

"6. Passing step by step from tanks to small canals large enough only to drink up the slender streams which the Deccan rivers contain after the monsoon is over. The feasibility of large canals was at length considered, and the result has, as already mentioned, completely reversed the view which was formerly held by all. It has been found by starting boldly with a high dam placed sufficiently close to the Ghats to afford command of level over the country below, but not so completely among them as to have too much declivity in the bed of the river to render the storage of water too costly, and carrying a large canal with a moderate fall from the head works so placed down the valley, and creeping steadily along the hill side, always gaining upon the country and getting nearer and

nearer to the water shed or summit of the ridge separating one valley from another, we obtained complete command of the country, a water supply that never failed, and the most material advantage of distributing the water over tracts of dry elevated country where the soil is thinnest, and where irrigation is not merely an improvement, but in all except remarkable seasons, an absolute necessity to enable the people to obtain crops at all."

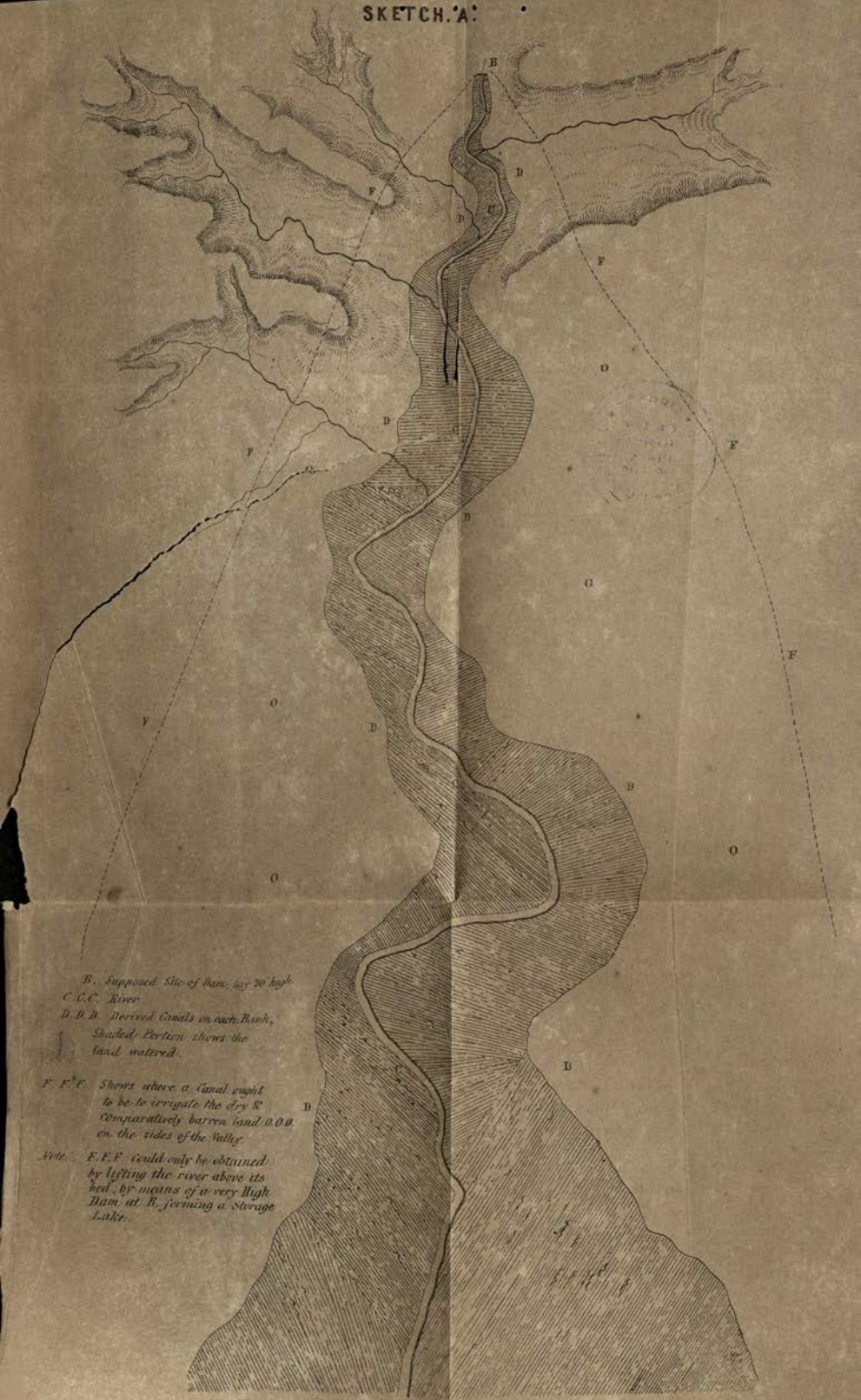
My own experience in the irrigation of the Dharwar districts completely confirmed his views with regard to tanks on the ordinary system. It scarcely pays us now to *restore* an old tank when the most expensive part of the work is already present to our hand, how much less would it do so had we to construct all the works from the beginning. I had also observed, that all the canals hitherto made merely watered the margins of the rivers, and that the land really requiring irrigation was not touched. I thus agreed with my predecessor in the principle, but had reason to think that the difficulties of the task were under-rated. I soon received a project prepared under Colonel Fife's directions, but not submitted previously to his departure (had it been so, he would doubtless have found the same fault with it that I did), for an immense storage lake on the Girna River in Khandeish, where it was cooly proposed to throw a dam over a river bed of pure sand. No arrangement was made to replace the sand by a more water-tight material, and a flood of 300,000 cubic feet per second (about the cold weather stream of the Indus) was to be thrown over a narrow waste weir on which it would rise to a height of some 17 or 18 feet; this led me in the present report, while acknowledging the ultimate necessity of large storage works, rather to enlarge upon the difficulties, and to stop the too great confidence in the facility of their execution, than to advocate their being undertaken hastily and without due consideration. I feel this explanation necessary, as it may be said that I raise difficulties which I do not solve. Such solution cannot be arrived at in a moment, and the present conclusion is I think a fair one, to undertake one such work the plans for which are nearly matured, and let it be a precedent and guide for others. I had also, in writing the first part of the report, the view of its being read at the usual Public Works Congress in the rains and eliciting discussion and opinions thereon.

REPORT.

1. The irrigation in this part of India presents this point of special difference to that in the North-west Provinces of the Bengal Presidency and Madras, viz. that whatever their other difficulties may be, they can throw the waters of their rivers on the lands that specially require irrigation, while we on our present system cannot. In the North-west provinces the canals have to contend against an excess of slope of the country through which they pass, which is obviated by masonry falls at the necessary intervals to retain a certain slope in the canal bed; for instance the Ganges Canal, leaving the parent stream at Hurdwar, has several falls before it reaches Roorkee, and as it goes on towards Cawnpoor, continues to require these descents: after passing Roorkee, it attains the backbone or watershed of the country, and commands a great extent of land towards the Ganges on one side and the Jumna on the other. In Madras the principal canal irrigation is confined to the Deltas at the mouths of the three great rivers, the Cauvery, Godavery, and Kristna, where, when once a dam of moderate height is built, the canal soon gets out on the surface, to command without further difficulty large tracts of land specially requiring artificial irrigation. In the Deccan and Southern Maratha Country, in the first place the rivers have so slight a slope of bed, that even with such a small fall as 9 to 1 foot in a mile in the canal, the fall of the river does not gain much on it, and this, coupled with the steep transverse slope of the valleys, prevents the canal getting away to any distance from the river itself; instead therefore of watering the dry and comparatively barren lands some distance from the river bed, the canal meanders through the already fertile land immediately in the vicinity, and being fertile without the canal, though its waters of course are a benefit to it, they are not of such consequence as they would be further away. The annexed rough sketch **A** will illustrate this.

2. This is one difficulty; the next is of even more serious importance: the invariable supply from the monsoon rains of the Western Ghats fills to overflowing all the rivers that have their

SKETCH 'A'



B. Supposed Site of Dam, say 70' high.
C.C.C. River.
D.D.D. Derived Canals on each Bank,
Shaded Portion shews the land watered.
F.F.F. Shews where a Canal ought to be to irrigate the dry & Comparatively barren land O.O.O. on the sides of the Valley.
Note. F.F.F. Could only be obtained by lifting the river above its bed, by means of a very High Dam at B. forming a Storage Lake.

source there, but only during and immediately after the wet season. At this time the land being already watered directly from the heavens, does not so much require an artificial supply. The first or kurreef crop fructifies in most seasons moderately well without the assistance of the rivers. It is when the long dry season of nearly eight months sets in, and the land gradually becomes dry and parched, that the rivers are looked to; but they have then nearly run dry, the copious monsoon supply is gone, and a mere thread of water in comparison remains, and that thread decreases to almost nil towards the termination of the hot weather.

3. To make the irrigation works pay, and to be of real importance to the country then, we require to effect two things: the one the commanding the barren lands on the side of the river valleys, the other the retaining some part of the copious streams that run away to waste during the rains, and to store them up till they are needed in the dry season. Works adapted to such storage solve the first problem also; as they must increase the height and therefore command of the waters above the country.

4. Our native predecessors in the part of the country I am reporting on, though thoroughly alive to the value of water for their lands, made but very partial efforts to solve the above two problems. Their storage works were confined to small tanks on tributary streams, useful in their way, but affording a very small area of irrigation in comparison to the country unwatered. The main rivers, as far as storage is concerned, were untouched. The tank system, as carried out by them, as a rule may be stated not to be a paying one, looking merely to the money profit on the capital sunk, simply because the dam and appurtenances cost too much in comparison with the value of the water stored, calculating such value by the extra revenue that the land irrigated by it pays. Many of the existing tanks were not made with the mere view of creating revenue. In many instances they were absolutely necessary to the neighbouring villages to supply water for man and beast, and as such were often erected as works of charity; the using the surplus supply for irrigation to gardens below being in these cases the secondary and not the primary purpose.

5. It is only to such tanks or lakes then in which the value of water stored for irrigation bears such a proportion to the cost of storage works (dam, waste weir, &c.) as to realize a profit on the outlay (without reference to other considerations), that our attention as irrigators should be directed, and it will be found that, save under very exceptional circumstances, the scale will not be turned in favour of profit until the tank becomes a very large one ; and to supply such immense reservoirs, we can only look to the large rivers, that is, we must find favourable sites on their courses where they can be dammed up at a profitable cost, which involves good features of the country for the dam and waste weir, and a sufficient area of land of good quality accessible to irrigation at a moderate cost for the supply canal works.

6. The latter requires little consideration. There is an unbounded area of land in a proper position to be watered and to pay handsomely for it, the difficulty lies in making the supplying lake, and that that difficulty may be appreciated. I may remark, that works on the scale required are quite without precedent. The reservoirs in Europe are quite in miniature in comparison, * and there are few if any in this part of India. I know of but one, and that a failure. I shall refer to it again further on.

7. Being therefore without Engineering precedent, and offering in itself plainly the risk of the greatest disasters, one naturally approaches the subject with hesitation and caution, and yet if we are to irrigate this country in the proper way its features indicate, we must grapple with it.

8. But before continuing, I will digress to make a few further remarks on the works of our predecessors as they have done so much, and in their way so well, that surprise will be expressed at my saying they have never carried out such works as I indicate as necessary. Let

* A Mr. Ellet proposed works of this kind at the head waters of the Mississippi and Ohio Rivers in America, but they have not as yet been carried out.

For comparison, it is not the height of the dam that should be looked to, but the capacity of the waste weir; as the latter shows the magnitude or otherwise of the flood to be contended with.

it be remembered that I am confining myself to the Deccan and Southern Maratha Country, but I believe Khandeish, our best canal irrigated district, offers no exception.

9. The native irrigation was then of two sorts, either by tanks or canals direct from rivers. Their tanks are as a rule small and erected on streams of little volume, as may be judged from the small capacity of their waste weirs. The dams are of moderate height, and what is of the greatest importance, the flood over the waste weir has but a small fall, and is of manageable proportions; in the only instance I know where these conditions were not fulfilled, a disastrous failure was the result, it happened to the work I before alluded to, a large tank* (near the village of Sut Koty) on the Mysore frontier of the Dharwar Districts.

10. Here the natural features of the country afforded a magnificent site for an enormous tank; a comparatively small but well-supplied river passed through a gorge in the hills, before approaching which the country was open, and the transverse slope towards the river slight. Some enterprising native, for the true name and history generally is lost, constructed a dam of vast dimensions (actually 800′ thick at bottom) across this gorge, and not contented with this mass of earthwork, revetted it with Cyclopean stones, particularly at the point where the river channel ran. The dam stood well, and is perfect to this day; but no sooner did the tank fill, than the river either sought for itself a waste weir, or found a small one made for it. This question cannot now be decided, because at this point, which was on a saddle of the natural hill, and of pretty hard rock, the water, rushing over with violence, and having a fall of 100 feet or more to reach its old bed, tore through and created a cut with almost perpendicular sides, through which it now runs nearly at its old level, thus making a new course for itself, and by contemptuously turning the artificial impediment of man, rendering his vast labours useless.

11. This is an excellent lesson for all who follow in that designer's footsteps, and the obviating the cause of his disaster will be

* The Maduk Tank.

found one of our great difficulties, which I shall again refer to. (Since writing this, I have found the following paragraph in a report of Colonel A. Cotton's, on a proposed lake of this description, called the Maury Tank). Speaking of such works and their requirements in the way of waste weirs, he says, "there are the remains of many vast bunds in such situations in different parts of the peninsula, I believe they were all breached, because their constructors had no idea of what was wanted in this way." So much for the native tank system, as a rule it is, where successful, on too small a scale and too costly for our purpose. I am aware that there are very large tanks in the Madras Presidency which pay a large revenue, but the features of that country must be different; from the comparatively small height* of their dams and small volume of water passing over their waste weirs, they show none of the difficulties of construction and maintenance which appear in those we require, and as I have shown where they have been exposed to such difficulties they have failed.

12. The other native system was that of canals direct from rivers, of which we have an excellent, nay magnificent, instance in the works on the Toongbadra. Here enormous stones were thrown in dry across the numerous rocky ridges in the river bed, so as to create dams or rather weirs of moderate height. From the head of water thus afforded, canals on either bank were supplied. The same system was applied in other rivers, only in smaller instances the dam or weir would probably be of masonry instead of simple rough stone. The canals so formed could not, from the peculiar features of this part of the country, get away to any distance from the parent river, and only supplied irrigation to a small belt of a mile or two wide on its bank, where the land was already fertile without artificial irrigation. It is this principle we have followed in our own works, not only on the Toongbadra, but elsewhere. We have made more scientific dams, but we have not been able, any more than our predecessors, to get our canals into that part of the country really requiring them.

13. I wish it to be understood that these works are pro-

* *See* Appendix.

fitable, and that we shall continue to carry them out, but that they utilize a very small portion of the monsoon supply, and make but little mark on the face of the country. I repeat that the real irrigation called for by the natural features of the land is a storage tank system, not on the small scale of old, but boldly seizing on the great rivers, and therefore believing I have noted the principal points which prove this to be the true requirement, and also that it is plain to us all that the plentiful waters of the monsoon should be kept in the country till they are wanted, I return to the subject of storage tanks on a large scale.

14. It is easy to prove that such tanks are wanted; it is not so easy to design and carry them out. I have remarked that we have no precedent, European or Native, to guide us, or rather that there is no European precedent at all, and the only Native one I know under far more favourable features of ground than we shall probably find, was a complete failure, from the same causes that will put all our skill to the test to combat.

15. The two great difficulties will be the dam and its waste weir. The dam must be of massive strength and have sound foundations. We are going to pile up a waste of waters above the country so great, that if the dam bursts, they may carry death and desolation for miles and miles along the valley below. The massive strength is a question of cost and skill merely, the foundations are a more difficult matter. Many a promising site in other respects fails in this, but I don't think we are justified at any rate in the infancy of this sort of work to proceed without securing it. (For instance, the report I have recently received from Mr. Brown, in Khandeish, shows that the site near Roxana, selected by Colonel Fife as likely to afford an excellent storage lake, fails from the river bed being nothing but sand, and by a difficulty amounting almost to an impossibility in obtaining sufficient width for a waste weir. Were we to throw a dam across the gorge, as proposed, lifting the water up to 100′ above its natural bed, it would either leak away through the sand under the dam, or burst through, blowing the dam up.)

16. The other and greater difficulty still, is the waste weir, we are not dealing with a petty stream that would make a pretty cascade

down the hill side, but with an impetuous torrent, a large river in flood formidable enough in its own bed with a moderate fall, but how much more so when it is thrown down a slope of a height nearly, if not quite, that of the Falls of Niagara.

17. My predecessor Colonel Fife has, in the Poona water supply project, grappled with one of these large tanks, and with great boldness, not contented with the great height of his present intended dam (85′) to the surface of the lake, he contemplates making it 30′ higher, so as to be in all 125′. Knowing the risk to be run, he paid the greatest attention to his project, which he prepared, aided by all the resources of his great irrigational experience and natural engineering skill. He was, in my humble opinion, too bold in the dimensions of his dam, to which, when carried out, I shall endeavour to persuade Government to add some more masonry. He had also turned his attention to some other storage lakes on a much larger river (the Girna, in Khandeish), the project for which is at present in abeyance, owing to the vital want of sound foundations. Many other sites for valuable storage offer, and will continue to offer themselves, but we must proceed cautiously, not recklessly. There are yet many of the simple canal works, offering but little risk and a good profit, to be carried out, which will keep us fully employed. Of the storage works, I should recommend Government to complete the Poona one first to its full extent, observe its advantages and defects, and then take it as a precedent to be, if successful, copied or improved upon in others, but not to commit themselves at first incautiously to many of these so necessary but hazardous undertakings.

18. Having thus, though in a brief and cursory way, indicated what I think must be the ultimate style of irrigational works to be carried out in the Deccan and Southern Maratha Country, I continue, by reporting on what is actually being done at the present moment, and what it is proposed at present to recommend. It being recollected that the eventual large storage tanks contemplated, so far from interfering with, or rendering the present works useless, will by the increased supply of water in the dry season they can afford to them, increase their utility, while though it is some time before cultivation takes full advantage of a canal, still those being and to be

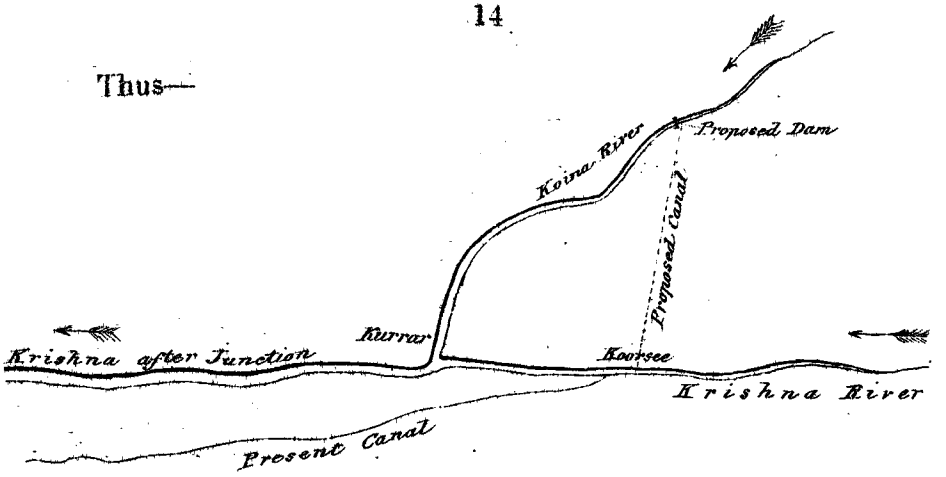
made, will be adding to the revenue of the country each year, and affording means for further developement of irrigation on a large scale.

19. I will first remark on the canal from the Kristna, near Kurrar, in the Sattara Collectorate, as it is a work fast advancing to completion, and will be a very fine example of the canal system, as it can only be carried out without vast storage reservoirs.

As this is intended to be a mere general report, I will not cumber it with details, which would be better given in a special one. The work consists then of a masonry dam of moderate height about 20′) thrown completely across the river bed, founded on a rocky ridge, which is itself a barrier or dam, and materially assists in giving a head of water. From above this dam, and with its bed 4 feet below the crest, a canal is excavated, provided with proper scouring sluices to keep its channel open, and a short distance down, and at a convenient point thereon, a head or regulating sluice is erected by which floods are shut out, and only the amount of water required by the canal admitted at will.

The canal then meanders on with a slope of 1′ per mile, carried across the transverse drainage of the country by proper masonry works, and gradually receding so far from the bank as to command a belt of land between it and the river, too narrow I am sorry to say for the wants of the Kristna valley. It is most painful to see fine land, capable of most profitable irrigation, lying but a few feet too high on the wrong side of the canal. (This is one of the evils spoken of in the commencement of this report. We want a greater head of water than our style of work in the Deccan affords.) Towards the tail of the canal however, this previously narrow belt widens out very considerably, in fact, the canal is, as it were, only beginning to tell on a large area of country when it terminates. Terminates, because by the time it has gone this distance, the supply of water in the dry season will have been exhausted on the land already passed through; but if we could by any means increase the summer supply, it might be prolonged with great advantage: to do this it is proposed to endeavour to find a suitable site for a dam over the adjacent river Koina.

Thus—



and to throw all its summer water into the Kristna above the present dam, which will materially aid the supply. The monsoon waters of the Koina may probably be in part utilized by a future canal along the right bank of the Kristna, after the junction of the two rivers, but this may rest for after consideration. There is a prospect also of our being able to make a storage lake on the Koina, which, in conjunction with the proposed dam and short canal across to the Kristna, would give us such a supply, as to enable the existing canal to be prolonged, and to fertilize a large tract at and beyond the point where it at present terminates. This supplement to the original design is now being surveyed for. There are hopes also of being able to obtain the small summer supply of the Yerla River, which our canal crosses at a favourable level.

20. Should the supplementary works I have noted turn out to be practicable, the Kristna canal will afford much more summer irrigation than at present intended: some alterations will then have to be made in the designed section and fall towards the tail, and this infers no delay in carrying out the present project, as some time must elapse before the work reaches the point at which the levels are intended to be altered. This is the only irrigation work actually in progress in the Sattara Collectorate. I recently inspected it and found it in good progress; the dam, head works, and first 10 miles of canal, should be ready before this year's monsoon, so that water can be admitted at once.

21. I visited also another small but finished work at Rewadee, in the vicinity of Sattara. An old native work that had failed had here been restored, and that so recently, that the cultivators had hardly got over their first doubts as to its success. They were now however appreciating its value, and jealous of any interlopers. Foreseeing that the demand would soon be greater than the supply, I wrote to the Collector, pointing out how valuable to the revenue this work would soon become, and begging that for the present, only temporary rates should be levied, with the object of raising them to their full and fair point after a year or so; and if properly managed, very high rates may be easily obtained, as the stream is perennial, and the ground commanded will become a garden.

22. We next come to the Belgaum Collectorate, where little if anything has ever been done in the way of irrigation, but where the rapid at the head of the Falls of Gokak, seems prepared by nature as a site for a canal. I copy here the principal portion of a report I recently made to the Revenue Commissioner on an irrigation project at this place.

"1. This river, taking its rise in the Western Ghats, has, like most of those in the Deccan, a full supply of water during and immediately after the monsoon; that is, until the end of November the supply for irrigational purposes, may, as Captain Wingate says, be called (practically) unlimited; but very soon after the termination of the rains, the stream dwindles to a mere thread in comparison with its former volume. On the 17th instant (*i. e.* February) I gauged the amount then running, and found it to be only 50 cubic feet per second. Colonel Fife, who made a similar measurement the year before, a few days earlier, found a similar quantity, and this amount of 50 cubic feet will probably dwindle down to 25′ or 30′ before the end of the hot season. (I am aware that in April and May casual freshes may be expected, but these soon run off without leaving the perennial supply augmented.)

"2. Profitable irrigation from this river, therefore, must first of all extensively employ the monsoon water for crops of rice and other cultivation for which irrigation up to the end of November will suffice, must at the same time store as much of the monsoon

flood as possible in tanks along the line of the canal, and finally use the remaining perennial stream in the canal, and the stored-up water in the tanks, for sugarcane and garden crops, the supply for which should be most carefully looked to to prevent waste, and be charged for at high rates, fairly settled with regard to the value of the crops fertilized by it.

"3. The natural facilities of the Gutpurba for all the above-mentioned descriptions of irrigation are very great; we are provided at once without cost with the first great requirement, a starting level (in this case 200 feet high), commanding an immense acreage of valuable land, for the river runs gently from the Ghats through the country, until it passes the village of Konoor, when it falls for about ½ a mile in rapids over sheets of rock, and finally leaps over a sheer precipice into the plains below, affording a most beautiful, nay sublime, spectacle.

"4. On the right bank a range of rocky hills accompanies the course of the river for some time before the falls are reached, and offers a great obstacle to a canal, which would have serious difficulty in getting through it, and once through, a ravine, caused by the Markundee river, would give additional trouble; but on the left bank, about two miles above the falls, the hills fall to a mere ridge, on cutting through which the canal at once comes upon a contour, which can be carried through the hills without difficulty until it dominates a fine plain of at least 400 square miles, lying between its course and the river, and finally reaches the crest of the watershed between the Gutpurba and the Kristna, thus affording irrigation to a part of the latter's valley also.

"5. The natural features above noted suggest the following scheme, which will in all probability be found feasible at a paying outlay when actually surveyed:—

"(1). To throw a dam or weir across the river at the nearest practicable point to the lowest part of the ridge to be cut through. The selection of the site for this work will require a careful instrumental survey. There is an excellent one (as far as a rocky bed and rising rocky banks to carry the wings into

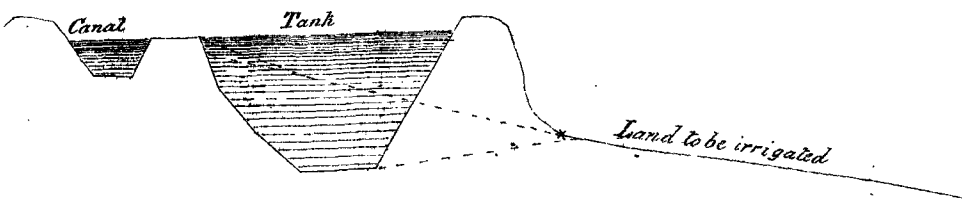
are concerned) just at the commencement of the rapid, some distance below the town of Konoor; but as the river is already ponded up at this point, and runs back very much on a level to the town of Konoor, which is situated on a rather low bank, there is some fear that any extra afflux caused by the dam, might in heavy floods inundate it. Moreover, the left bank at this point being nothing but sheet rock, the initial cutting would I fear be found very costly. I should prefer, if possible, placing the dam above the town of Konoor, where the bed of the river is again rock throughout, and being dry, and above the pond, evidently has a considerable command over the lower site, which will decrease the initial cutting, and moreover, having no town immediately above to be flooded, the dam can be raised higher. An advantage, as in this case, it will I think be found much cheaper to raise a foot of dam than excavate an extra foot of canal. I foresee difficulties however which may render this upper site impracticable. The river runs in three channels, and the banks are very low.

"(2). Then from above this dam, on the left bank of the river, to make a canal of such a capacity as to be able to carry the extreme monsoon supply that can be utilized. Such a canal to be carried as much as possible on a contour line, so as to avoid expensive excavation or embankment, the more so, as from the great height above the plains from which it starts, its bed will be in hard and probably rocky ground for a great portion at any rate of its course. As this canal during the hot season will carry a very small supply, which would be wasted by absorption and evaporation if thrown on a wide and shallow bed, its section should be narrow at bottom and broadly widening out above.

"(3). Along the course of this canal tanks should be made at every suitable site. The selection of a suitable site, after the practicability is once determined, involving simply the consideration of cost in comparison with the value of the water stored; these tanks should be so arranged, that their surface level should be that of the canal in full volume, their waste weirs should be very large, so as to act as an escape as well for the

tanks as the canal, and the sluice gate supplying them should if possible be self-acting. The freshes in April or at other times should be taken advantage of to refill them. The general feasibility of their construction is evident; the canal is so high above its parent river, that allowing a considerable loss of head for the depth of the tank, its bottom must still be above a great extent of land.

Thus—*



"6. I think I have noted all that is necessary to show the description of works proposed and their practicability; a few words will suffice to show the prospect of their being remunerative.

"7. In the first place, nature having done so much, the works should not be costly in comparison with the amount of land to be irrigated, or in other words, the profit to be realized.

"8. The quantity of land commanded by the canal is more than can ever be irrigated, therefore the demand for water will be greater than the supply, which ought to tell well upon the rates to be levied.

"9. The only doubtful point in the project, is the fact that throughout all the first part of the canal the land to be irrigated belongs to Jagheerdars, and is not directly under Government control; but Jagheerdars know the value of water as well as tenants holding

* NOTE.—I only indicate sites for tanks in this position, as likely to be found, as the canal contours round the valleys. In some cases, however, it may be preferable to make the tank lower down the valley, with its flood surface considerably below the canals, but still well above a large area of country between it and the river.

Sketch Map
of the
Country showing how the sectioned lines run

No 1 Shews the line of the Section taken at Kureekuttee
No 2 That taken Viâ Hoswal

(Signed) J. W. Playfair, Lieut Colonel R.E
Superintend^t Engineer for Irrigation

Lithographed at the Surv^r Engineer's Office P.W. Bombay May 1856

immediately from Government. This doubtful point has already been discussed. Captain Wingate thought that there would be no difficulty."

Instructions have been prepared for Lieutenant Smith, who has been appointed the Executive Engineer for Irrigation in this part of the country; it is to be hoped he will now be able quickly to mature a completely detailed project for submission to Government.

23. Another important river is the Mulpurba, which, taking its rise in the Western Ghats, has the constant full monsoon supply, but as usual a mere stream in the lower part of its bed in the hot weather. Colonel Fife gauged it at Khanapoor on the 19th December, and found only 31 cubic feet per second. I gauged it at the same place on the 24th February, and found 21 cubic feet per second.

24. This river has been looked to by Collectors and others, and lately by His Excellency Sir Bartle Frere, Governor of Bombay, not for the mere irrigation of the land in its vicinity, but for that of the Dharwar cotton plains, throughout which water is very scarce. The reason that the Mulpurba supply has been supposed likely to be available, is that on its course near Somudutee there are some very remarkable features. A line of hills crosses the track of the river, through which it passes by a very narrow chasm or rent, which offers great facilities for a dam even of stupendous size. The Trigonometrical map also shows that the backbone or division of the watershed is close to the river at this point, and to the eye the bank or crest that forms the watershed is of no great height. (The tracing from the Trigonometrical map, which accompanies, should be here referred to.) How simple does it seem to throw a dam across the gorge somewhere between the villages of Katurhal and Kulolee, and lead the water away either through the valley by the village of Hoswal or by that of Kurreekuttee.

Moreover, it does not only seem simple on the map, but it does also to a person on the spot. The eye however is not always to be relied upon.

25. Some years ago, in consequence of a report made by Mr. Shaw, then an Assistant Collector, who proposed a dam as above, and

a cutting by Hoswal, I took some levels from Hoswal downwards towards the river. I have not the papers by me, but my recollection is, that finding there was a rise of 110′, and that I had not commenced nearly at the crest, I gave the project up as hopeless. I have now again taken it up, still I fear with little hopes of success. Much more surveying however is required before finally reporting it as impracticable. This we know however, that the work in any case must be one of enormous magnitude. The dam across the gorge must be of great height, and the river having but a small fall of bed, the inundation will go far back up its course. From the nature of the valley, barren hills with a little strip of cultivation on the banks of the river, and also from the want of water elsewhere, the villages will be seen to be close to the river all the way along. They would *all* be submerged, and the little strip of land whose cultivation supports them would be lost also.

26. Even this dam of stupendous height, say 130 feet, would not raise the level of the surface to the crest of the ridge. A cutting of an extreme depth of 50 feet and of $3\frac{1}{2}$ miles in length, *vide* the accompanying section, taken at Kurreekuttee, would be required in order to tap the upper 30 feet layer of the tank only. When this was done, and not till then, the water would come out on the Dharwar plains.

27. The next thing to be looked to is the waste weir; some channel for the surplus water must be formed or cut (I fear the latter) through the range of barrier hills, over which a flood of waters must be passed and thrown down a slope of 130 feet or more to the parent river in the neighbourhood of Manolee.

28. Altogether, taking into consideration the loss of property and land involved in the long inhabited valley that would form the tank's bed, the enormous and costly works required to utilize the supply when found, and the doubt whether the extra profit to be raised from the already fertile Dharwar plains would at all pay a remunerative percentage, I myself consider the scheme as one never likely to be undertaken.

29. Colonel Fife, who had heard reports founded on my

Section thro' the Ridge at Hoswal

Towards Cheolkee, shewing it not to be so advantageous for the Canal as Kureekuttee it is 22' higher and allowing 8 Ft extra fall in the Canal to reach it, the extra cutting would be 30' more than at Kureekuttee

The red shading shews the cutting for the same canal line that would get thro' Kureekuttee at a depth of 50'. The black shading The cutting corresponding to the 100' at Kureekuttee
Sharwar Cutting plane
Sutlej Kurka River
150'
35 Miles
9 Miles
1 Mile
1 Mile

Scale 1 Mile to an Inch Horizontal
100 feet to an Inch Vertical

Superintending Engineer, Irrigation Office.
Poona, 27th April 1866

(Signed) John W. Playfair, Lieut Colonel R.E.
Superintending Engineer 3rd
Irrigation.

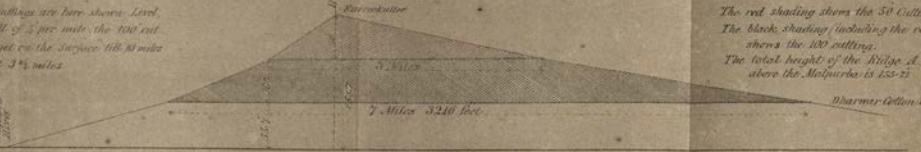
Submitted with Superintending Engineer's Letter No. dated May 1866

11003

Section showing cutting through the Ridge at Kurreekuttee

NOTE.

The cuttings are here shewn Level, but with a fall of ½ per mile the 100 cutting will just get on the Surface 6th 30 miles and the 50 at 3 ⅝ miles



The red shading shews the 50 Cutting. The black shading (including the red) shews the 100 cutting. The total height of the Ridge A. B above the Malpurba is 455 ft

Calculation for 100 cutting to deliver 300 C ft per second. Slope of bed ½ per mile. Width 10. side Slopes ¾ to 1

63,600739 Total Cost 33 Lacs

Horizontal Scale 1 mile to 1 inch.

Vertical Scale 100 to 1 inch.

Calculation for 50 cutting delivery, slope &c. same as above

14,892247 C ft. @ 3 ½ 100 C ft. Total Cost 5 Lacs

John Wm Playfair. Lieutt Colonel.

former examination (for I believe I was the only one who ever took an instrument to the place), suggested, that instead of attempting to draw water so low down as this, we should commence our works as high as Khanapoor, or rather at a rocky barrier about 1½ miles above that town.

I have recently visited Khanapoor and the rocky barrier alluded to, and have also traversed the whole valley from Khanapoor to Manolee. The result, so far as I yet know, and the irrigating the Dharwar cotton plains is concerned, is still very unsatisfactory. From the map and look of the country, one would naturally suppose that a canal with a moderate head at Khanapoor would cross the ridge at Kurreekuttee, but our old enemy, the want of fall in the river, again interferes. A contour for a canal, with a fall of one foot per mile, has been run from the ridge at Kurreekuttee to the village of Toomurree, at which point, after winding at a terrible loss of fall for miles round the valleys, it was still 160′ above the river. Knowing the hopelessness of carrying such a contour on further, I ordered the leveller to drop 50 feet and proceed, intending to recover that fall by a cut through the Kurreekuttee ridge. The result was, that on arriving at the barrier, 1½ miles above Khanapoor, his level was still 106·89 above it, and the line had traversed 124 miles from Kurreekuttee. The barrier at Khanapoor is 32·64 below the ridge at Kurreekuttee, although 36 miles up the valley as the crow flies. The ridge at Kurreekuttee is 156′ above the river in its immediate vicinity. These levels are very unfavourable; the survey is still being proceeded with, to try if a large storage lake is practicable at Khanapoor, in which case, supposing the canal to start 50′ above the barrier, and to cut through the ridge at Kurreekuttee at a depth of 50′, it would have a fall of 67 feet between the two points, with which it may probably be successfully led through the valley.

30. The following are the plans for irrigation from the Mulpurba that present themselves for examination, and which are in course of being finally decided on one way or another :—

(1.) To make a storage lake at Khanapoor, and from a high level to lead a canal cutting through the dividing ridge

somewhere near the village of Kurreekuttee, and finally watering the Dharwar plains.

(2.) Or this being impracticable, still to make a storage tank, and to water both sides of the Mulpurba's own valley.

(3.) Or to do the same without a storage tank. This latter offers very little prospect of profit indeed. The land on the margins of the river, as far as where the main road to Dharwar crosses, is already a mass of rice fields irrigated directly by the rain fall, which is here very abundant.

(4.) To make an enormous lake by damming up the gorge between Katurhal and Kololee—*see* preceding paragraphs.

(5.) The country has been levelled for a site for a dam near Manolee, but nothing profitable can be done, owing to the hills again coming precipitously down to the river about Toragul. A dam might be made below Ramdoorg, and a belt of irrigation obtained along both banks. This is but a small work, and a lame conclusion to the vast projects we have been speaking of; it may be found eventually worth taking up, and very likely be the only paying project on the river.

31. No other schemes for Dharwar and Belgaum are at present projected. I know the Dharwar districts well, and that save some altogether minor and doubtful works, there is nothing to turn our attention to save the Wurda River. I have examined it (when Executive Engineer, Dharwar) for almost the whole length of its course in the Bombay Presidency, and never hit upon any scheme to ulitize its waters. I believe a large storage tank would be the only likely plan, and a site for that would have to be sought higher up its course in the Mysore districts. There are two works, the important part of which I executed before I left Dharwar, viz. the drawing water out of the Muduk tank by a new sluice, and the dam and canal over the Kulhala nullah near Misreekote. The former has now been handed over to me, and as soon as Lieutenant Smith is settled in his appointment, I will take charge of the latter also.

32. On visiting Sholapoor on my return, I found the can-

tonment and town very much in want of a good supply of water. I sent a report to the Superintending Engineer Southern Division, giving my advice as to the best way of repairing the existing tank, &c., but the true remedy is the construction of the magnificent tank at Ekrookh, for which the plans and estimates have long since been sent in to Government by this Department. I took the opportunity of his camp being in the neighbourhood, to meet the Revenue Commissioner on the spot where the tank dam is to be constructed ; it appears that there is a hitch, owing to the fact that some small portion of land, and one or two villages to be submerged, belong to the Nizam ; but as although temporarily inconvenienced, the Nizam's people will eventually gain by having such a supply of water, with facilities for cultivating the valuable ground on the margin, as the tank dries up, and as a fair compensation will be allotted, this difficulty, with a little trouble and determination, might be easily got over.

J. W. PLAYFAIR, Lieut. Colonel, R.E.,
Superintending Engineer for Irrigation.

FALL IN FEET PER MILE OF DIFFERENT RIVERS IN THE DECCAN AND ELSEWHERE.

DHARWAR DISTRICTS—

Toongbadra river	2′ to 2½′	per mile.
Wurda river (Dharwar District)	2′	do.

BELGAUM DISTRICTS—

Malpurba river	1¼′ to 1½′	do.
Gutpurba, below the Falls of Gokak	1′ and 2″ per mile. 14″	

SATTARA DISTRICTS—

Krishna (above Dam at Koorsee)	4·7′	per mile.
Koorsee* to above Bahey Falls	1·9′	do.
Bahey Falls to Yerla Junction	1·4′	do.
Below Yerla Junction	0·6′ or 7⅛″	do.
Koina (from Helwāk, to Kurrar)	1·3′	do.
from Kurrar to above Bahey Falls	0·4′	do.
from Bamnolee upwards	6′	do.
Yerla (from Krishna Junction to Chicklee)	8·8′	do.
Maun (from Deeguchee to Munswur)	5·5′	do.

POONA DISTRICTS—

Neera (above Ramliswur)	4·6′	do.
Inderownee	2·75′	do.
Bheema (Sarowlee to Deksal)	2·75′	do.

SHOLAPORE—

Seena (above Oondugaum)	2·75′	do.
GANGES—(at Soor Kurtal)	1·5′	do.
(Gurmukteshwur to 60 miles south)	1·25′	do.
(Cawnpoor to Allahabad)	0·75′	do.
JUMNA—(at Agra)	1·25′	do.
INDUS—(towards Sukkur)	0·75′	do.

J. W. PLAYFAIR, Lieut. Colonel, R.E.

* The greater part of this Fall is at Koorsee.

APPENDIX.

Dimensions of two of the largest tanks in the Madras Presidency, taken from Baird Smith's Report on the Madras Irrigation, to illustrate the remark in page 10 of the Report; it will be seen that the dimensions are not formidable, and yet they have at times been exposed to great dangers and saved with difficulty from floods:—

"Chumbrumbaukum, one of the finest in the Madras Presidency. Embankment 3 miles, 5 furlongs, 20 yards in length, varying from 9 to no less than 28 feet in thickness, and from 16 to 26 feet in height; area 9½ square miles; volume 3,000 millions of cubic feet; its safety during floods is insured by the action of 6 waste weirs, giving in the aggregate a breadth of escape channel of 676 feet, with a depth below the crest of the embankment varying from 6 to 13 feet according to position; through this area an enormous mass of water can escape, as the supply is dependent almost exclusively on natural rainfall and merely local drainage; the protective provision has proved adequate and breaches have been very rare.

Cauvery Pauk Tank, fed by a canal from the Pellar River. Embankment 3¾ miles, area 7 miles; greatest water spread 2 miles; bank 28′ high; 2 waste weirs; combined length 580."

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on 10 January, 2019